REMARKS

Claims 9-16 are pending in this application. In the Office Communication mailed September 13, 2007, the Examiner maintained the rejection of Claims 9-16 under 35 U.S.C. 102(b) as being unpatentable over U.S. Patent No. 6,061,624 to Kashimura et al. ("Kashimura"). Applicants request that the Examiner favorably consider the following remarks.

With regard to independent Claim 9, Kashimura fails to teach or suggest the limitation: "continually determining a parameter that depends on an <u>acceleration</u> of the internal combustion engine by a monitoring and analysis method." In contrast, Kashimura determines a combustion state parameter by obtaining a <u>differential revolution speed</u> between a specific cylinder and a revolution speed in other cylinders. The Examiner argues at page 3 of the September 13, 2007 Office Communication that [d]ifferential revolution speed is a change in speed, acceleration is a quantity defined as the rate at which an object changes its speed. Therefore, *acceleration and differential revolution speed differ only in name but identical in meaning.*" Applicants respectfully submit the Examiner's position is incorrect.

It is a fundamental principle in the field of physics that differential speed and acceleration are not equivalents because differential speed is based on a change in speed regardless of direction, while acceleration is based upon a change in velocity in a specific direction. Velocity and speed <u>are not</u> equivalents. *See* the documents collectively entitled "The Physics Classroom Documents" pages 1-6 and 1-5 both attached hereto, available by visiting www.physicsclassroom.com/Class/1DKin/U1L1d.html and www.physicsclassroom.com/Class/1DKin/U1L1e.html. The attached Physics Classroom Documents set forth the difference between differential speed and acceleration, and speed vs. velocity. Acceleration is a vector quantity which is defined as "the rate at which an object changes its velocity." An average acceleration can be calculated by the simple formula $V_f - V_i/t$. Velocity is a vector quantity, <u>which unlike speed</u>, accounts for the direction of a moving object. It is "direction-aware." Speed, on the other hand, is a scalar quantity that simply is concerned with how fast an object is moving. Accordingly, acceleration, which takes into account velocity, is not equivalent to a differential revolution speed because differential revolution speed between one cylinder and another for example, does not account for a direction of movement.

To illustrate the differences between speed and velocity, and thus differential speed and acceleration, Applicants request the Examiner consider the following relevant example

discussing uniform circular motion. Suppose an object is moving in a circle around some central point at a specific speed. The speed does not change, but the velocity vector is always changing, indicating that the body is accelerating towards the center of the circle. In other words, if one got into a car and drove around a curve, he or she would feel a force towards the outside of the curve, despite the fact that his or her speed is not changing. This is due to the individual accelerating towards the center of the curve. Thus, the vector nature of velocity provides concrete differences between acceleration and differential revolution speed. *See* the Examples of The Physics Classroom documents for further examples of the differences between speed and velocity, and thus differential speed and acceleration.

Further support for the fact that acceleration and differential speed are not identical in meaning can be elucidated by considering how the parameter of the claimed invention (that depends on an acceleration of the internal combustion engine by a monitoring and analysis method) may be based upon an individual cylinder while the parameter of Kashimura necessarily requires a plurality of cylinders. As discussed above, Kashimura determines a combustion state parameter by obtaining a differential revolution speed between a specific cylinder and a revolution speed in other cylinders. Conversely, the parameter of Kashimura may represent a value for an individual cylinder. *See* paragraph [0026] of the present application: "The segment times are the time intervals which the crankshaft requires during the power strokes of the individual cylinders." *See also* paragprah [0026] of the present application: "If the acceleration index falls below the threshold value, this signifies that the cylinder [(note singular usage)] in question has made no or only the inadequate torque contribution in this operating point, which is generally attributed to a misfire."

In view of the above, Applicants submit that Kashimura does not teach or suggest the limitation of "continually determining a parameter that depends on an acceleration of the internal combustion engine by a monitoring and analysis method" as required by Claim 9, and all claims dependent therefrom. An indication of allowance of Claim 9 is respectfully requested on the basis of the above arguments alone.

Additionally, Applicants respectfully submit that Kashimura fails to teach or suggest that "a variance in [an acceleration] parameter is determined and used to adjust [a] threshold value to take account of changes in the even running of the internal combustion engine" as is also required by independent Claim 9. Put another way, Kashimura does not adjust its threshold

value to take account of changes in the even running of the internal combustion engine. Instead, Kashimura discloses at col. 2, lines 12-23:

> The present invention, which diagnoses by measuring revolution speed of a multi-cylinder engine for each cylinder, obtaining differential between a revolution speed in a specific cylinder and a revolution speed in other cylinders as combustion state parameter, and comparing the combustion parameter with a prescribed threshold level, is characterized by obtaining a plurality of the above-mentioned combustion state parameters corresponding to the prescribed number of times of ignition including ignition of the above-mentioned specific cylinder, and correcting a value of the above-mentioned threshold level as a function of the plurality of combustion state parameters.

Accordingly, Kashimura fails to teach or suggest that "a variance in [an acceleration] parameter is determined and used to adjust [a] threshold value to take account of changes in the even running of the internal combustion engine" since the threshold value of Kashimura is instead corrected (adjusted) "as a function of the plurality of combustion state parameters" or, in other words, based upon an average of the combustion state parameters. *See* col. 2, lines 12-24 and col. 6, lines 51-57 of Kashimura. For the above reasons, Applicants thus also submit that Claim 9, and all claims dependent therefrom, are in condition for allowance.

Claims 10-16 are dependent on Claim 9, and thus incorporate the limitations of Claim 9. Therefore, for the reasons set forth above with respect to Claim 9, Claims 10-16 are in condition for allowance.

Applicants note that dependent Claim 10 requires that "the threshold value is increased if there is a reduction in the even running of the engine and reduced if there is an increase in the even running of the engine." This feature is not discussed in Kashimura. Instead, Kashimura discloses at col. 7, lines 25-28 that "...when a state in which a change in the combustion state parameter $D(n,m)$ is too large (equal to A2 or more)..., a revolution sensor is assumed to be abnormal, a prescribed value C1 is added to the misfire judgment level Dth [(the threshold value)]. First, as discussed above, Kashimura fails to teach or suggest that "a variance in [an acceleration] parameter is determined and used to adjust [a] threshold value to take account of changes in the even running of the internal combustion engine." Second, Kashimura fails to teach or suggest that "the threshold value is increased if there is a reduction in the even running of the engine and reduced if there is an increase in the even running of the engine" as a value is

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added to the threshold value when the combustion state parameter is too large in Kashimura. Thus, dependent Claim 10 is patentable over Kashimura for these additional reasons.

In addition, Applicants note that Claim 15 requires "an even running regulation method is used to correct the combustion in the cylinders of the internal combustion engine to increase the even running of the engine and the variance of the parameter is used to check the result of the even running regulation." This feature is not at all discussed in Kashimura. Thus, dependent Claim 15 is patentable over Kashimura for these additional reasons.

Conclusion:

The commissioner is hereby authorized to charge any appropriate fees due in connection with this paper, or credit any overpayments to Deposit Account No. 19-2179.
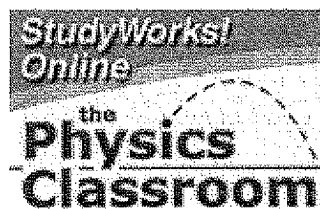
Respectfully submitted,

Dated: 11/8/07

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Lesson 1: Describing Motion with Words

Acceleration

The final mathematical quantity discussed in Lesson 1 is acceleration. An often misunderstood quantity, acceleration has a meaning much different from the meaning sports announcers and other individuals associate with it. The definition of acceleration is:

Acceleration is a <u>vector quantity</u> which is defined as "the rate at which an object changes its <u>velocity</u>." An object is accelerating if it is changing its velocity.

Sports announcers will occasionally say that a person is accelerating if he/she is moving fast. Yet acceleration has nothing to do with going fast. A person can be moving very fast, and still not be accelerating. Acceleration has to do with changing how fast an object is moving. If an object is not changing its velocity, then the object is not accelerating. The data at the right is representative of an accelerating object – the velocity is changing with respect to time. In fact, the velocity is changing by a constant amount - 10 m/s - in each second of time. Whenever an object's velocity is changing, that object is said to be accelerating; that object has an acceleration.

Time (s)	Velocity (m/s)
0	0
1	10
2	20
3	30
4	40
5	50

▶ **Animation**

Constant Acceleration

Sometimes an accelerating object will change its velocity by the same amount each second. As mentioned before, the data above shows an object changing its velocity by 10 m/s in each consecutive second. This is known as a constant acceleration since the velocity is changing by the same amount each second. An object with a constant acceleration should not be confused with an object with a constant velocity. Don't be fooled! If an object is changing its velocity – whether by a constant amount or a varying amount – it is an accelerating object. An object with a constant velocity is not accelerating. The data tables below depict motions of objects with a

constant acceleration and with a changing acceleration. Note that each object has a changing velocity.

Accelerating Objects are Changing Their Velocity ...

... by a constant amount each second ...	
Time (s)	**Velocity (m/s)**
0	0
1	4
2	8
3	12
4	16

...in which case, it is referred to as a constant acceleration.

... or by a changing amount each second ...	
Time (s)	**Velocity (m/s)**
0	0
1	1
2	4
3	5
4	7

...in which case, it is referred to as a non-constant acceleration.

Since accelerating objects are constantly changing their velocity, you can say that the distance traveled divided by the time taken to travel that distance is not a constant value. A falling object for instance usually accelerates as it falls. If you were to observe the motion of a free-falling object (free fall motion will be discussed in detail later), you would notice that the object averages a velocity of 5 m/s in the first second, 15 m/s in the second second, 25 m/s in the third second, 35 m/s in the fourth second, etc. Our free-falling object would be accelerating at a constant rate.

Given these average velocity values during each consecutive 1-second time interval, the object falls:

– 5 meters in the first second,
– 15 meters in the second second (for a total distance of 20 meters),
– 25 meters in the third second (for a total distance of 45 meters),
– 35 meters in the fourth second (for a total distance of 80 meters).

These numbers are summarized in the table below.

Time Interval	Average Velocity During Time Interval	Distance Traveled During Time Interval	Total Distance Traveled from 0 s to End of Time Interval
0 - 1 s	5 m/s	5 m	5 m
1 - 2 s	15 m/s	15 m	20 m
2 - 3	25 m/s	25 m	45 m
3 - 4 s	35 m/s	35 m	80 m

This discussion illustrates that a free-falling object which is accelerating at a constant rate will cover different distances in each consecutive second. Further analysis of the first and last columns of the table above reveal that there is a square relationship between the total distance traveled and the time of travel for an object starting from rest and moving with a constant acceleration.

For objects with a constant acceleration, the distance of travel is directly proportional to the square of the time of travel.

As such, if an object travels for twice the time, it will cover four times (2^2) the distance; the total distance traveled after two seconds is four times the total distance traveled after one second.

If an object travels for three times the time, then it will cover nine times (3^2) the distance; the distance traveled after three seconds is nine times the distance traveled after one second.

Finally, if an object travels for four times the time, then it will cover sixteen times (4^2) the distance; the distance traveled after four seconds is sixteen times the distance traveled after one second.

Calculating Acceleration

The acceleration of any object is calculated using the equation:

$$\text{Ave. acceleration} = \frac{\Delta \text{velocity}}{\text{time}} = \frac{v_f - v_i}{t}$$

This equation can be used to calculate the acceleration of the object whose motion is depicted by the velocity-time data table above. The velocity-time data in the table shows that the object has an acceleration of 10 m/s/s. The calculation is shown below:

$$a = \frac{v_f - v_i}{t} = \frac{50 \text{ m/s} - 0 \text{ m/s}}{5 \text{ s}} = \frac{10 \text{ m/s}}{1 \text{ s}}$$

Acceleration values are expressed in units of velocity per time. Typical acceleration units include the following:

m/s/s
mi/hr/s
km/hr/s

Since accel'n is ΔV/t, its units would be velocity units per time units.
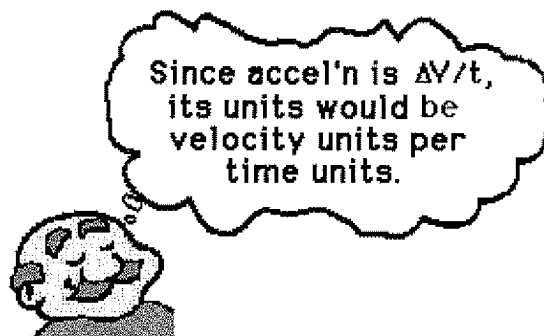
Initially, these units are a little awkward to the newcomer to physics. Yet, they are very reasonable units when you consider the definition of and equation for acceleration. The reason for the units becomes obvious upon examination of the acceleration equation.

$$a = \frac{\Delta \text{velocity}}{\text{time}}$$

Since acceleration is a velocity change over a time interval, the units for acceleration are velocity units divided by time units – thus

(m/s)/s or (mi/hr)/s.

Direction of the Acceleration Vector

Acceleration is a <u>vector quantity</u> so it will always have a direction associated with it. The direction of the acceleration vector depends on two factors:

- whether the object is speeding up or slowing down
- whether the object is moving in the positive (+) or negative (−) direction

The general RULE OF THUMB is:

If an object is slowing down, then its acceleration is in the opposite direction of its motion.

This RULE OF THUMB can be applied to determine whether the sign of the acceleration of an object is positive or negative, right or left, up or down, etc. Consider the two data tables below.

In Example A, the object is moving in the positive direction (i.e., has a positive velocity) and is speeding up. When an object is speeding up, the acceleration is in the same direction as the velocity. Thus, this object has a positive acceleration.

In Example B, the object is moving in the negative direction (i.e., has a negative velocity) and is slowing down. When an object is slowing down, the acceleration is in the opposite direction as the velocity. Thus, this object also has a positive acceleration.

Example A		Example B	
Time (s)	Velocity (m/s)	Time (s)	Velocity (m/s)
0	0	0	-8
1	2	1	-6
2	4	2	-4
3	6	3	-2
4	8	4	0

These are both examples of positive acceleration.

This same RULE OF THUMB can be applied to the motion of the objects represented in the two data tables below.

In Example C, the object is moving in the positive direction (i.e., has a positive velocity) and is slowing down. When an object is slowing down, the acceleration is in the opposite direction as the velocity. Thus, this object has a negative acceleration.

In Example D, the object is moving in the negative direction (i.e., has a negative velocity) and is speeding up. When an object is speeding up, the acceleration is in the same direction as the velocity.

Thus, this object also has a negative acceleration.

Example C			Example D	
Time (s)	Velocity (m/s)		Time (s)	Velocity (m/s)
0	8		0	0
1	6		1	-2
2	4		2	-4
3	2		3	-6
4	0		4	-8

These are both examples of negative acceleration.

▶ **Animation**

Check Your Understanding

To test your understanding of the concept of acceleration, consider the following problems and their corresponding solutions. Use the equation to determine the acceleration for the two motions below.
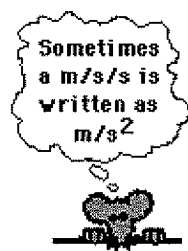
Practice A			Practice B	
Time (s)	Velocity (m/s)		Time (s)	Velocity (m/s)
0	0		0	8
1	2		1	6
2	4		2	4
3	6		3	2
4	8		4	0

Depress mouse to view answer to Practice A.

Depress mouse to view answer to Practice B.

Sometimes a m/s/s is written as m/s^2

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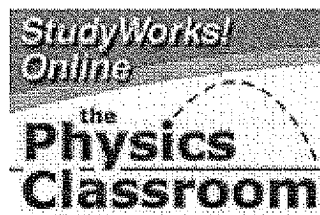
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Lesson 1: Describing Motion with Words

Speed and Velocity

Just as distance and displacement have distinctly different meanings (despite their similarities), so do speed and velocity.

Speed is a scalar quantity which refers to "how fast an object is moving." A fast-moving object has a high speed while a slow-moving object has a low speed. An object with no movement at all has a zero speed.

Velocity is a vector quantity which refers to "the rate at which an object changes its position." Imagine a person moving rapidly - one step forward and one step back - always returning to the original starting position. While this might result in a frenzy of activity, it would also result in a zero velocity. Because the person always returns to the original position, the motion would never result in a change in position. Since velocity is defined as the rate at which the position changes, this motion results in zero velocity. If a person in motion wishes to maximize his/her velocity, then that person must make every effort to maximize the amount that he/she is displaced from his/her original position. Every step must go into moving that person further from where he/she started. For certain, the person should never change directions and begin to return to where he/she started.

Describing Speed and Velocity

Velocity is a vector quantity. As such, velocity is "direction-aware." When evaluating the velocity of an object, you must keep track of its direction. It would not be enough to say that an object has a velocity of 55 mi/hr. You must include direction information in order to fully describe the velocity of the object. For instance, you must describe an object's velocity as being 55 mi/hr, east. This is one of the essential differences between speed and velocity. Speed is a scalar and does not keep track of direction; velocity is a vector and is direction-aware.

The task of describing the direction of the velocity vector is easy! The direction of the velocity vector is the same as the direction in which an object is moving. It does not matter whether the object is speeding up or slowing down, if the object is moving rightwards, then its velocity is described as being rightwards. If an object is moving downwards, then its velocity is described as being downwards. Thus

Velocity is Speed with a direction.

an airplane moving towards the west with a speed of 300 mi/hr has a velocity of 300 mi/hr, west. Note that speed has no direction (it is a scalar) and that velocity is simply the speed with a direction.

Average Speed and Average Velocity

As an object moves, it often undergoes changes in speed. For example, during an average trip to school, there are many changes in speed. Rather than the speedometer maintaining a steady reading, the needle constantly moves up and down to reflect the stopping and starting and the accelerating and decelerating. At one instant, the car may be moving at 50 mi/hr and at another instant, it may be stopped (i.e., 0 mi/hr). Yet during the course of the trip to school the person might average a speed of 25 mi/hr.

▶ **Animation**

The average speed during the course of a motion is often computed using the following equation:

$$\text{Average Speed} = \frac{\text{Distance Traveled}}{\text{Time of Travel}}$$

Meanwhile, the average velocity is often computed using the equation:

$$\text{Average Velocity} = \frac{\Delta \text{position}}{\text{time}} = \frac{\text{displacement}}{\text{time}}$$

Example

The following problem will test your understanding of these definitions:

> While on vacation, Lisa Carr traveled a total distance of 440 miles. Her trip took 8 hours. What was her average speed?

To compute her average speed, simply divide the distance of travel by the time of travel.

$$v = \frac{d}{t} = \frac{440 \, \text{mi}}{8 \, \text{hr}} = 55 \, \text{mi/hr}$$

That was easy! Lisa Carr averaged a speed of 55 miles per hour. She may not have been traveling at a constant speed of 55 mi/hr. She undoubtedly, was stopped at some instant in time (perhaps for a

bathroom break or for lunch) and she probably was going 65 mi/hr at other instants in time. Yet, she averaged a speed of 55 miles per hour.

Instantaneous Speed

Since a moving object often changes its speed during its motion, it is common to distinguish between the average speed and the instantaneous speed. The distinction is as follows:
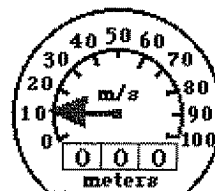
Instantaneous Speed - speed at any given instant in time.

Average Speed - average of all instantaneous speeds; found simply by a distance/time ratio.

You might think of the instantaneous speed as the speed which the speedometer reads at any given instant in time and the average speed as the average of all the speedometer readings during the course of the trip.

Constant Speed

Moving objects don't always travel with erratic and changing speeds. Occasionally, an object will move at a steady rate with a constant speed. That is, the object will cover the same distance every regular interval of time. For instance, a cross-country runner might be running with a constant speed of 6 m/s in a straight line. If her speed is constant, then the distance traveled every second is the same. The runner would cover a distance of 6 meters every second. If you measured her position (distance from an arbitrary starting point) each second, you would notice that her position was changing by 6 meters each second. This would be in stark contrast to an object which is changing its speed. An object with a changing speed would be moving a different distance each second. The data tables below depict objects with constant and changing speeds.

An object moving with a constant speed of 6 m/s

Time (s)	Position (m)
0	0
1	6
2	12
3	18
4	24

An object moving with a changing speed

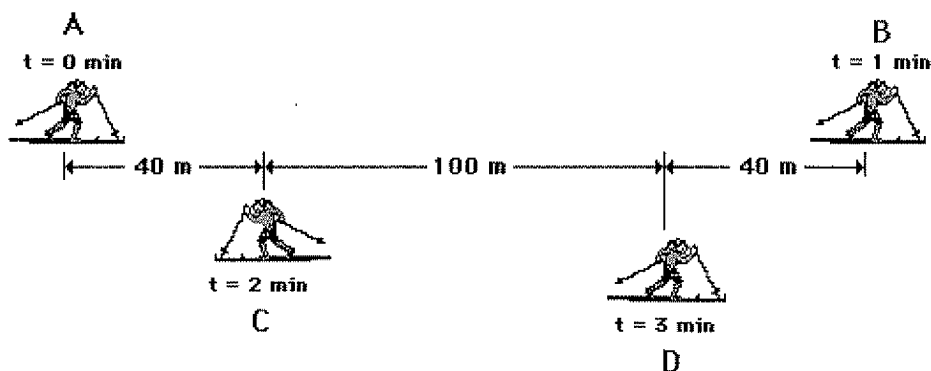| Time (s)	Position (m)
0	0
1	1
2	4
3	9
4	16

Example

Now let's try a more difficult case by considering the motion of that physics teacher again. The physics teacher walks 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North. The entire motion lasted for 24 seconds. Determine the average speed and the average velocity.
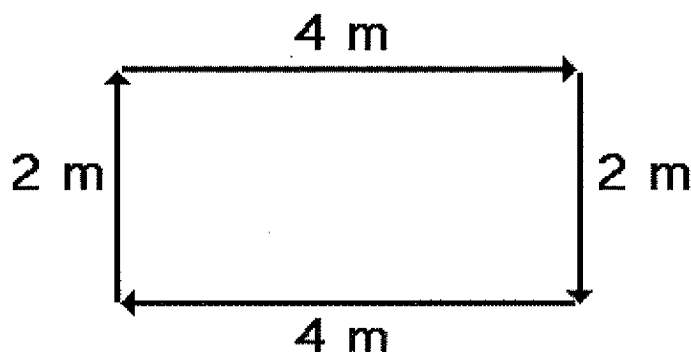
The physics teacher walked a distance of 12 meters in 24 seconds; thus, her average speed was 0.50 m/s. However, since her displacement is 0 meters, her average velocity is 0 m/s. Remember that displacement refers to the change in position and that velocity is based upon this position change. In this case of the teacher's motion, there is a position change of 0 meters and thus an average velocity of 0 m/s.

Exercise 1

Here is an exercise similar to one seen before in the discussion of distance and displacement. The diagram below shows the position of a cross-country skier at various times. At each of the indicated times, the skier turns around and reverses the direction of travel. In other words, the skier moves from A to B to C to D. Use the diagram to determine the average speed and the average velocity of the skier during these three minutes. When finished, depress the mouse on the pop-up menu to see the answer.

Depress mouse to see answer.

Exercise 2

Seymour Butz views football games from under the bleachers. He frequently paces back and forth to get the best view. The diagram below shows several of Seymour's positions and times. At each marked position, Seymour makes a "U-turn" and moves in the opposite direction. In other words, Seymour moves from position A to B to C to D. What is Seymour's average speed and average velocity? Depress the mouse on the pop-up menu below to see the answer.

D	B	C	A
t = 10 min	t = 3 min	t = 6 min	t = 0 min

Position (yds)
-10   0   10   20   30   40   50
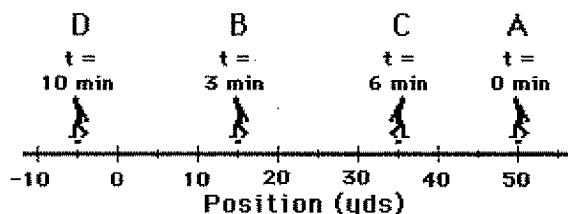
Depress mouse to see answer.

In conclusion, speed and velocity are kinematic quantities which have distinctly different definitions. Speed, a scalar quantity, is the distance (a scalar quantity) per time ratio. Speed is ignorant of direction. On the other hand, velocity is direction-aware. Velocity, a vector quantity, is the rate at which the position changes. It is the displacement or position change (a vector quantity) per time ratio.

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